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EFFECT OF BAMBOO FIBER IN SELF COMPACTING CONCRETE PARTIALLY REPLACING CEMENT WITH GGBS AND ALCCOFINE

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ABSTRACT

An attempt has been made in the present investigation to study the effect of Eco-bamboo fibers on the strength behavior of FRSCC partially replacing cement with GGBS and Alccofine. An innovative natural plant bamboo fiber where more atmospheric CO2 could potentially be sequestered and it is extracted by using mechanical method was used in this study and cement being costly, replaced by waste material GGBS,ALLCOFINE is added to produce high strength and performance concrete .A mix proportion of SCC was arrived by using trial and error method and w/c ratio was maintained constant for all the mixes. The bamboo fibres of 1% (l/d ratio=40 which already evaluated by experiment) of 4.9mm length to the weight of cement are added to the SCC which cement is partially replaced by 30% GGBS and 10% of Alcofine. The outcome of using bamboo fibers in the compressive strength, split tensile strength and the flexural behavior has been studied. The addition of bamboo fibers also made the concrete very resistive in flexure and maximum improvement in 28 days strength was observed to be 6.1 N/mm2, hence addition of bamboo fiber content increases the flexural strength in scc also with the replacement of GGBS and alccofine.

Key words: Bamboo fiber; Alccofine; GGBS; fiber reinforced concrete; high strength; Self-compacting concrete.

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1. INTRODUCTION

SCC is now an emerging technique in the field of concrete technology. SCC is an innovative idea to tackle the problem of concreting through dense reinforcement. SCC is unique, because of its properties, like fill ability, flow ability, pump ability, and make production of concrete more industrialized [1]. It becomes necessary to develop a compaction free production system thereby reducing the overall cost of the project, improve the work quality and providing safety in the work environment [1].

The use of SCC will lead to a industrialized production, decrease the technical cost of in situ cast concrete constructions, enhance quality, durability, reliability of concrete structures and eliminate some of the potential for human being error. It will replace manual compaction of fresh concrete with a modern semi-automatic placing technology and in that way improve health and safety in and around the construction site [2].

The concept of fibers in a brittle mix was first recorded with Egyptians who used a hair of animals and straw as reinforcement for bricks and walls in housing. These fibers will provides the various mechanical properties and design applications. Natural plant fibers are now widely used for engineering fields as substitution for manufacturing fibers. However less potential is required to raise those fiber productions on the earth because of less land to grow for those natural plants. For that the solution is Bamboo, which is having the characteristics of both grass and wood. it is very strong in its longitudinal direction due to strong fiber bundles [3].

2. EXPERIMENTAL INVESTIGATIONS

2.1. Materials

2.1.1. Cement

Ordinary Portland cement-53 grade had used in experiment. its tested according to IS 4031:1988 and confirmed to IS 12269:2004.Table 1 show the Physical characteristics of cement (OPC 53 grade.

Table 1 Physical characteristics of cement (OPC 53 grade)

Properties	Test Method	Test Results	Limitations As per IS 12269-2004
Normal Consistency in (%)	Vicat Apparatus (IS:4031Part- 4)	33%	30 -35 %
Specific Gravity	Sp. Gr bottle (IS: 4031Part-4)	3.12	≤ 3.15
Initial Setting Time	Vicat Apparatus(IS: 4031 Part - 5)	40 Min	>30
Final Setting time		220 Min	<600
Fineness of cement	Sieve test on 90μSieve (IS: 4031 Part-1)	5.00%	< 10%

2.1.2. Coarse Aggregates

The aggregate of size greater than 4.75mm is considered as coarse aggregate. Regarding the characteristics of different types of aggregate, crushed aggregates tend to improve the strength because of the interlocking of the angular particles, while rounded aggregates improve the flow because of lower internal friction. Locally available crushed granite aggregate passing through 12 mm and retaining on 4.75mm was used for all of the mixes of concrete. Table 2 shows the Physical characteristics coarse aggregate.

Table 2 Physical characteristics coarse aggregate

No	Physical properties	Results	Code of reference
1	Specific gravity	2.5	IS 2386 part 3-1986
2	Water absorption	0.15%	IS 2386 part 3-1986
3	Bulk density(kg/m3)	1366(loose)1439(rodded)	IS 2386 part 3-1986
4	Finess modulus	2.81	IS 2386 part 2-1986
5	Impact value	9.76%	IS 2386 part 3-1986
6	Loss angles abrasion	35.4%	IS 2386 part 3-1986
7	Flakiness index	14.06%	IS 2386 part 3-1986
8	Elongation index	62.4%	IS 2386 part 3-1986

2.1.3. Fine Aggregates

Aggregate of size less than 4.75mm is considered as fine aggregate. Both crushed and rounded sands / Siliceous and calcareous sands can be used. The fine aggregate content should be in the range of 1/4th to 1/3rd of the total volume of the mixture. Fine aggregate plays a very important role in the reduction of segregation. Locally available sand passing through 4.75mm sieve was used for all of the mixes of concrete. The aggregates used were conforming to zone II according to IS: 383-1970.Table 3 shows Physical properties of Fine Aggregate

Table 3 Physical properties of Fine Aggregate

No	Physical properties	Results	Code of reference
1	Specific gravity	2.5	IS 2386 part 3-1963
2	Finess modulus	2.81	IS383-1970
3	Bulking	10%	IS 2386 part 3-1963
4	Bulk density	1432(loose)1600(rodded)	IS 2386 part 3-1963

2.1.4. Super Plasticizer (SP)

It is a chemical compound used to develop the workability without using any additional water. The super plasticizer used in the present work is the commercially available brand Glenium B233. Table 4 shows Properties of Glenium B233 (Super plasticizer)

Table 4 Properties of Glenium B233 (Super plasticizer)

Parameters	Results	Specifications(as per IS 9103)
Physical state	Light brown liquid	Light brown liquid
Chemical name of active Ingredient	Polycarboxylate Polymers	Polycarboxylate Polymers
Relative density at 25 C	1.083	1.08±0.02
Ph	6.92	Min.6
Chloride ion content (%)	0.0079	Max 0.2
Dry material content	34.58	34 (±5%)

2.1.5. Bamboo Fibers

Bamboo fibers are natural fibers that are extracted from the bamboo tree and used as substitution for natural plant fiber having many benefits such as low price, low density, eco-friendly, sustainability and biodegradability[3]. In this study bamboo fibers are extracted by using mechanical method was used. Scanning electron microscopy test has been conducted to find the micro structure of bamboo fibers and failure analysis as well as the diameter of bamboo fiber [4].different stages of bamboo fiber extraction was shown in the figure 1 to figure 5.

Figure 1 Different ages of raw bamboo

Figure 2 Longitudinal striped bamboo

Figure 3 Longitudinal striped bamboo under roller

Figure 4 Bamboo fiber of diameter 1.156mm Of aspect ratio (l/d)=40

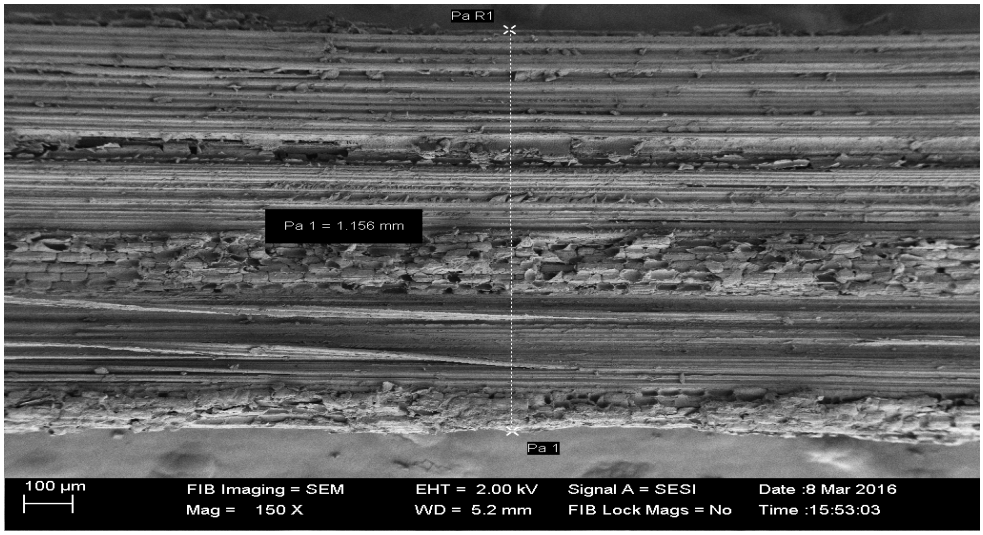

Figure 5 Scanning electron micro scoping image of bamboo fiber diameter 1.156mm.

2.1.6. Alccofine

Alccofine is high glass content, high reactivity and special product formed through the process of controlled granu-lation its raw material primarily consists of low calcium silicates. This meting out with other select ingredients results in controlled particle size distribution. It reduces water requirement for a given workability and resulted in improved compressive strength.

2.1.7. GGBS: Filler

Ground granulated Blast furnace slag cement is in use for moderately long period due to the overall economic system in their creation as good as their enhanced performance characteristics in aggressive environments. GGBS is received by using quenching molted iron slag from a blast kiln in water or steam to supply a glassy grainy product. Then it is dehydrated and grounded in to a best powder. In the last decade a fine deal of study work Has been performed addressing the effectively of GGBS. Table 5 shows Physical Properties of GGBS.

Table 5 Physical properties of GGBS

Sl.no	Physical Properties	GGBS
1	Specific Gravity	2.65
2	Fineness modulus	2.83
3	Bulk density(loose, compacted)(kg/m3)	1346, 1480

3. RESULTS

In the present studies an attempt has been made to determine the effect of bamboo fiber by examining their workability and strength characteristics has been presented under various heading and tabulated in tables and figures. The compression and split tensile strength test were conducted by the same compression testing machine which has a capacity of 200 tones.

3.1. Fresh Properties of SCC

The slump value varies from 655 mm for normal self compacting concrete to the 725 mm for 1% fiber content. the slump values with corresponding fiber content is as shown in the table 6 and The workability tests are carried out for the mixes NSCC,PM1 with fiber content 1%.its observed that results confirms to minimum and maximum recommended values. As an increase of fiber content the slump flow also increases linearly. Thus the bamboo fibers are suitable for SCC as it satisfies most of the workability recommendation of EFNARC.

Table 6 Workability of Fresh BFRSCC

Sl No	Description	SCC	PM1	EFNARC Values	
				Min	Max
1	Slump flow (mm)	655	725	650	800
2	T50 cm Slump flow (sec)	4	2	2	5
3	V-funnel (sec)	9	7	6	12
4	V-funnel T5 Min (sec)	13	8	0	3
5	L-box (H2/H1)	0.8	0.95	0.8	1

3.2. Hardened Characteristics of BFRSCC

3.2.1. Compressive Strength

The compressive strength tests are conducted to ensure a minimum strength is achieved by the particular mix. The test for determining compressive strength for concrete employs a cube specimen of 150mmX150mm size and allowed cure in water and self for 7, 14, and 28 days which is subjected to compression in a compression testing machine. The test results of Compressive strength are shown in Table 7 and figure 6.As noted from the above results the strength has increased by 5% than normal SCC (control concrete) with 1% of bamboo fibers.

Table 7 Variation of compressive strength for different mix proportions

Sl.No	Mix	Average Compressive Strength N/mm2		
		7 Days	14 Days	28 Days
1	SCC +Alccofine+GGBS(NSCC)	22.9	30.8	33.8
2	SCC +Alccofine+GGBS+Bamboo fibres(PM1)	24.1	33.2	37.4

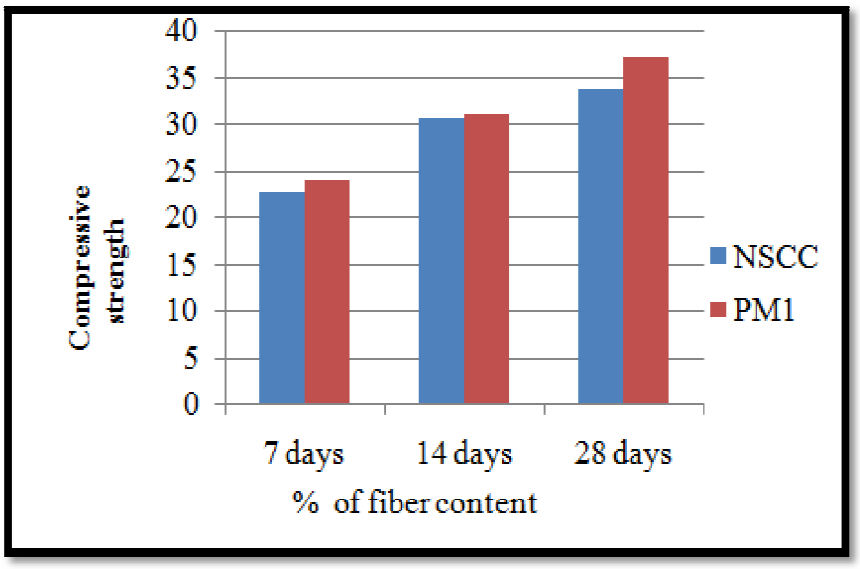

Figure 6 variation of compressive strength for different mix proportion

3.2.2. Split Tensile Strength

The split tensile strength test for concrete employs a cylinder specimen of 150 mm X 300 mm size which allowed to cure in water for 7, 14 and 28 days and tested in a compression testing machine. The test results of split tensile strength for different mix proportions are shown in Table 8 and Figure 7.

Table 8 Variation of split tensile strength for different mix proportions

Sl.No.	Mix	Split Tensile Strength (N/mm^2)		
		7 Days	14 Days	28 Days
1	SCC +Alccofine+GGBS(NSCC)	2.2	2.9	3.8
2	SCC+Alccofine+GGBS+Bamboo fibres(PM1)	3.4	4.2	5.2

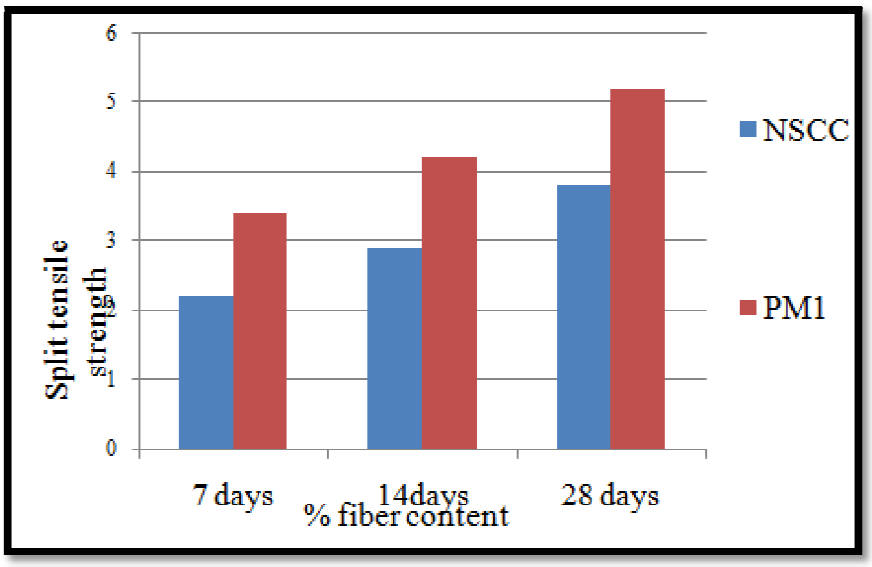

Figure 7 variation of split tensile strength for different mix proportions

3.2.3. Flexural Strength

The Flexural strength test for concrete employs a beam specimen of 150 mmX150mmX450mm size of beam which allowed to cure in water for 7, 14 and 28 days which is subjected to flexure in a universal testing machine. The test results of flexural strength for different mix proportions are shown in Table 9 and Figure 8.

Table 9 Variation of Flexural strength for different mix proportion

No	Mix	Flexural strength (N/mm^2)		
		7 Day	14 Day	28Day
1	SCC+Alccofine+GGBS	3.6	4.5	4.9
2	SCC+Alccofine+GGBS+Bamboo fibres(PM1)	4.1	5.7	6.1

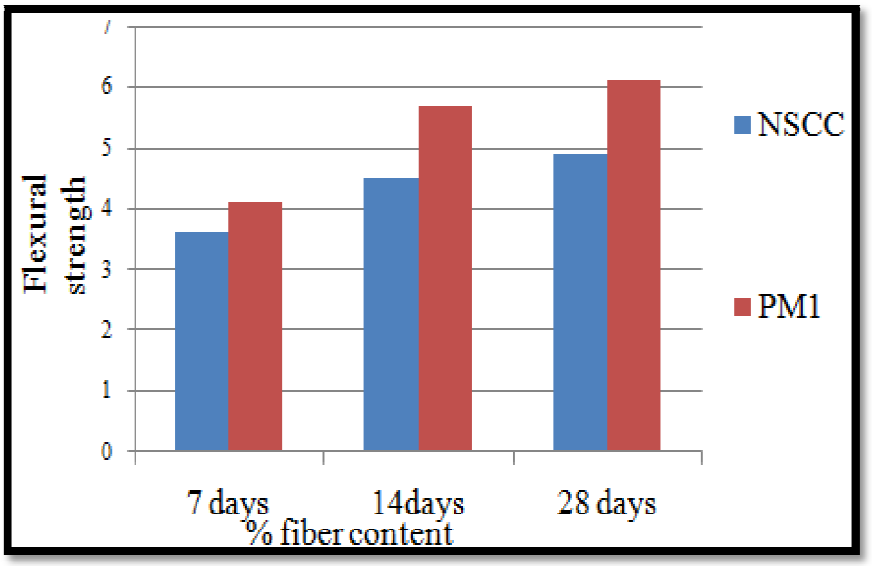

Figure 8 Variation of flexural strength for different mix proportion

4. CONCLUSION

From the study the following conclusion are drawn:

- Considering economical and environmental issues, Being cement costly and considering co2 release due to cement it can be replaced by cementious property material GGBS and alccofine which reduced co^2 release by 40%
- The workability of fresh concrete was found to decrease with an increase in the fiber content and also a decrease in the workability with the increase in the aspect ratio.
- The addition of bamboo fibers at 1.0% by weight causes a significant enhancement in early as well as long term compressive strength and split tensile strength of concrete. The maximum improvement in 28 days strength was observed to be 35.4 $N/mm^2$and 5.2 N/mm^2 ,hence 1% fiber content is optimum fiber content for aspect ratio of 40 from compressive and split tensile strength view.
- The addition of bamboo fibers makes the concrete very resistive in flexure and maximum improvement in 28 days strength was observed to be 6.1 N/mm2, hence addition of fiber content increases the flexural strength.
- Mix design for SCC can be carried out by Nan-Su method which is considered as a simple mix design and the dosage of super plasticizer will be determined by trial and error as substantial result of properties of fresh and hardened concrete.

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REFERENCES

[1] Nan Su, Kung-Chung Hsu and His -Wen Chai G, June 2001. “A simple mix design method for self-compacting concrete”, Cement and Concrete Research.

[2] Hajime okamura and Masahiro1ouchi, “Self Compacting Concrete”, Journal of advanced concrete technology, Vol 1, pp 5-15, 2003.

[3] Nguyen tien phog,toru fujii,bui chuong,kazuya okubo,”study on how effectively extract bamboo fibres from raw bamboo and waste water treatment”journal of materials science research”vol 1,pp145-150,jan 2012.

[4] P.Zakikhani,R.zahari,M.T.H.Sultan,D.L.Majid”bamboo fibre extraction and its reinforced polymer composer material”international journal of chemical,molecular,nuclear,materials and metallurgical engineering,vol 8,no.4,2014.

[5] Masakazu terai & koichi minami,Reasearch and development on bamboo reinforced concrete structure,15WCEE2012.

[6] B. Sarath Chandra Kumar and K. Ramesh, Durability Studies of GGBS and Metakaolin Based Geopolymer Concrete. *International Journal of Civil Engineering and Technology*, 8(1), 2017, pp. 17–28

[7] John Paul V. and Antony Rachel Sneha M., Effect of Random Inclusion of Bamboo Fibers on Strength Behaviour of Flyash Treated Black Cotton Soil. *International Journal of Civil Engineering and Technology,* 7(5), 2016, pp.153–160.